CABOT

DESIGN SPECIFICATIONS FOR CABOT CORPORATION'S CANAL SO_2 AND NO_x CONTROL SYSTEM

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NO_X AND SO_2 EMISSIONS CONTROL SYSTEM

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1.0 INTRODUCTION

In satisfaction of Paragraphs 18 and 27 of the Clean Air Act consent decree (the "Consent Decree") executed between Cabot Corporation, the United States and the State of Louisiana and entered by the Court on March 11, 2014, this document presents the Design Specifications for the NO_x and SO_2 Control Systems to be installed at Cabot's carbon black production facility in Franklin, LA ("Canal"). In accordance with the provisions of the Consent Decree, the NO_x and SO_2 Control Systems are designed to control emissions of Nitrogen Oxides (NO_x) and Sulfur Dioxide (SO_2) from the Canal Plant Process Systems.

In accordance with Paragraph 26 of the Consent Decree, the NOx control system is a Selective Catalytic Reduction ("SCR") system. In accordance with Paragraph 17 of the Consent Decree, the SO_2 control system is a Wet Gas Scrubber System ("WGS").

Cabot has compiled the qualitative and quantitative characteristics that establish the necessary criteria for defining the final design and performance requirements for the emissions control system. These specifications are intended to ensure that the design of the SO_2 and NO_x emissions control systems are consistent with the SO_2 and NO_x Process Systems Operation Emissions Limits and Control Technology requirements established in Paragraphs 17 and, 26 of the Consent Decree.

The following information provides a description of the existing Process Systems at the Canal Plant, an explanation of the design basis for the NO_x and SO_2 Control Systems, and identification of the design specifications for the NO_x and SO_2 Control Systems. This document also includes a generalized Process Block Flow Diagram for the proposed emissions control systems installation.

At this point in the design and engineering phases of system development, the current information constitutes only the preliminary design of the NO_x and SO_2 Control Systems; the information provided in this Design Specification does not reflect the final design for the systems. As such, the information in this document reflects currently available information, including preliminary data from potential suppliers of the equipment, and is subject to change.

2.0 EXISTING PROCESS SYSTEMS

Cabot manufactures a variety of carbon black products at the Canal facility, using a variety of heavy oil feedstocks as the primary raw material. The sulfur content of these feedstocks typically ranges from 0.3% to 4.0%.

During carbon black production, heavy oil feedstock is injected into hot gases downstream of a natural gas fired burner under sub-stoichiometric (oxygen-deficient) conditions. The natural gas burner exhaust and feedstock are contained within a refractory-lined cylindrical reactor. The lack of oxygen combined with the high carbon-to-hydrogen ratio of the feedstock supports the production of carbon black. The structural, chemical and physical properties of the carbon black are controlled by varying the feedstock composition, the temperature within the reactor and the carbon black reactor quench time.

Under the sub-stoichiometric (oxygen-deficient) reaction of the feedstock, carbon black is conveyed within the combustion waste gas (tail gas). In addition to the carbon black particles, the tail gas stream contains carbon monoxide (CO), hydrogen ($H_{2,}$), organic sulfides and other unreacted byproducts from the reactor. The carbon black and tail gas mixture is cooled and the carbon black is separated from the tail gas using a fabric filter (Main Unit Filter). The separated carbon black is further processed according to customer specifications, stored and shipped from the facility. The tail gas, which has calorific value, is either used as a fuel for process heating, or combusted in a central incinerator.

The combusted tail gas or flue gas from the process heaters is combined in a single duct which flows to the 318-foot tall main plant stack. The excess tail gas that is not consumed by the process heaters is collected in a common header and directed to the existing tail gas incinerator where it is burned to destroy hazardous air pollutants. The incinerator exhaust temperature is controlled with a water quench system to protect downstream equipment and is directed to the main stack along with the process heater exhaust.

3.0 DESIGN BASIS FOR EMISSIONS CONTROL SYSTEMS

The flue gas treatment system will be designed to treat 100% of the flue gas generated from combusting the tail gas from the reactors and process heaters at Cabot Canal carbon black facility. The two existing flue gas streams (incinerator exhaust and process heater exhaust) will be combined, and the combined stream will be directed to the NO_x and SO_2 control systems. In addition, particulate matter will be controlled in the WGS system consistent with the equipment performance capabilities for the particle size distribution of the particulates in the tail gas. The control system project includes the emissions control equipment, instrumentation and ductwork downstream of the existing tail gas incinerator and process heater flue gas ducts.

Primary components of the new emissions control system include a selective catalytic reactor (SCR), wet gas scrubber (WGS) system, reagent handling and preparation, ID fan, exhaust stack, solid waste processing and continuous emissions monitoring system (CEMS).

The system will also include a Heat Recovery Steam Generator (HRSG), installed by a third party, to replace the water quench system to control the flue gas temperature. The HRSG will also house the SCR catalyst.

The NO_X emissions control system (SCR) will be designed to be capable of reducing NOx emissions at the outlet to no more than 39 ppm as a 365-day rolling average, and 61 ppm as a 7-day rolling average, both at 0% oxygen.

The SO_2 emissions control system (WGS) will be designed to be capable of achieving at least a 95% reduction of the inlet SO_2 concentration, based on an inlet SO2 concentration of 1280 to 3900 ppmvd (at 0% oxygen).

After the SCR, the flue gas would pass through a dry induced draft (ID) fan upstream of the WGS. The flue gas would enter the WGS and pass through the scrubbing section where the SO_2 will be reacted with lime slurry. The resulting calcium sulfite will be oxidized using forced oxidation in the base of the WGS to create calcium sulfate (gypsum). The flue gas will pass out though entrainment separators in the top of the WGS to a new stack. Final stack height will be based on final equipment design and site-specific conditions.

Cabot proposes using pulverized limestone in the WGS. The pulverized limestone would be delivered by truck to minimize onsite material handling. Based upon current data on the site water quality and feedstock composition, no liquid discharge is expected from the facility due to operation of the WGS. The gypsum will be dewatered onsite using a vacuum belt filter and transported by truck to a licensed landfill.

The best available information concerning the current flow and composition range of the flue gas streams produced by the Canal Plant Process Units are shown in Table 1. These values are based on current operating information and are used as the design basis for pollutant loading at the inlet to the SCR. (Note: These data are based on historical operational and test data, adjusted to reflect the use of a heat recovery boiler for flue gas temperature control rather than a water quench system).

TABLE 1 – CANAL PLANT FLUE GAS FLOWS AND COMPOSITIONS

Parameter	Units	Maximum Flue Gas Flow	Normal Flue Gas Flow	Minimum Flue Gas Flow
Total Flow	Lb/hr, wet	1,280,174	1,037,580	286,899
Total Flow	SCFM	308,096	249,836	69,479
Molecular weight, wet	kg/kmol	26.3	26.3	26.1
NO_x as NO_2	Lb/hr	390	332	74
NO_x	ppmvd@0%O_2	367	334	291
SO_2	lb/hr	3,467	2,066	533
SO_2	ppmvd@0%O_2	2345	1734	1507
H_2O	% vol, wet	28.7	28.8	30.6
CO_2	% vol, wet	5.8	5.9	6.2
N_2	% vol, wet	60.5	60.4	59.2
O_2	% vol, wet	5.0	4.9	4.0
Normal Temp	°F (°C)	1468 (798)	1486 (808)	1690 (921)
PM load	grains/dscf	0.069	0.069	0.069

4.0 DESIGN SPECIFICATIONS

Cabot has contracted with two equipment suppliers to prepare preliminary design packages for the NOx and SO2 emissions control systems for the Canal Facility. The two designs are comparable and consistent with the performance standards described above. The descriptions below are general and representative of the main components; final design details will be determined based on additional engineering and analyses.

SCR Design Specifications

To meet the intended NO_X emissions reduction performance standard, Cabot is evaluating alternatives for the SCR reagent consisting of either 40% liquid urea or 19% aqueous ammonia.

The current base case design incorporates 40% liquid urea. The liquid urea would be converted to ammonia utilizing a natural gas burning pyrolysis type system. A dilution air skid provides dilution and combustion air to the decomposition chamber. A pyrolysis reaction occurs which breaks down the urea into ammonia. The ammonia gas is sent to the ammonia injection grid. The ammonia injection grid will be located upstream of the SCR in the optimal location to provide sufficient mixing with the flue gas prior to entering the SCR.

Cabot is also investigating the possibility of direct injection of 19% aqueous ammonia. This system would incorporate metering pumps and air atomization nozzles to inject ammonia directly into the hot flue gas duct upstream of the HRSG at a location designed to ensure adequate mixing prior to entering the SCR.

Regardless of the selected reagent, SCR catalyst beds will be installed within the horizontal flow path of the HRSG between the evaporator and economizer sections. Preliminary design indicates that a minimum of two layers of catalyst will be required to decrease NO_x emissions, optimize catalyst life and fit within the planned plant outage cycle. The expected temperature at the inlet to the SCR is approximately 550°F – 650°F. The HRSG has not been selected and design details are subject to change.

Wet Gas Scrubber (WGS) Design Specifications

To meet the intended SO_2 emissions reduction performance standard, Cabot is proposing to install a wet flue gas desulfurization system with forced oxidation. Cabot plans to use pulverized limestone as the reagent for the WGS.

The expected system design will include an open spray tower absorber with an integral reaction tank and exhaust stack. The absorber diameter is expected to be between 26 and 28 feet. The absorber will have two spray levels, two absorber recirculation pumps and two stage mist eliminators.

The reaction tank will incorporate a forced oxidation system. The system includes air compressors, air injection lances and side entry mixers.

The limestone storage silo will contain a minimum of three days of projected limestone use for the maximum projected SO_2 inlet concentration. The limestone will be mixed with water to prepare a lime slurry which will be pumped into the absorber tower.

The gypsum dewatering system concentrates the gypsum solids produced in the absorber as a result of SO_2 removal, and returns the recovered filtrate water to the absorber. The dewatering system is designed to be closed loop or zero liquid discharge (ZLD). The only moisture that exits the absorber system is the moisture contained in the gypsum cake and the saturated flue gas.

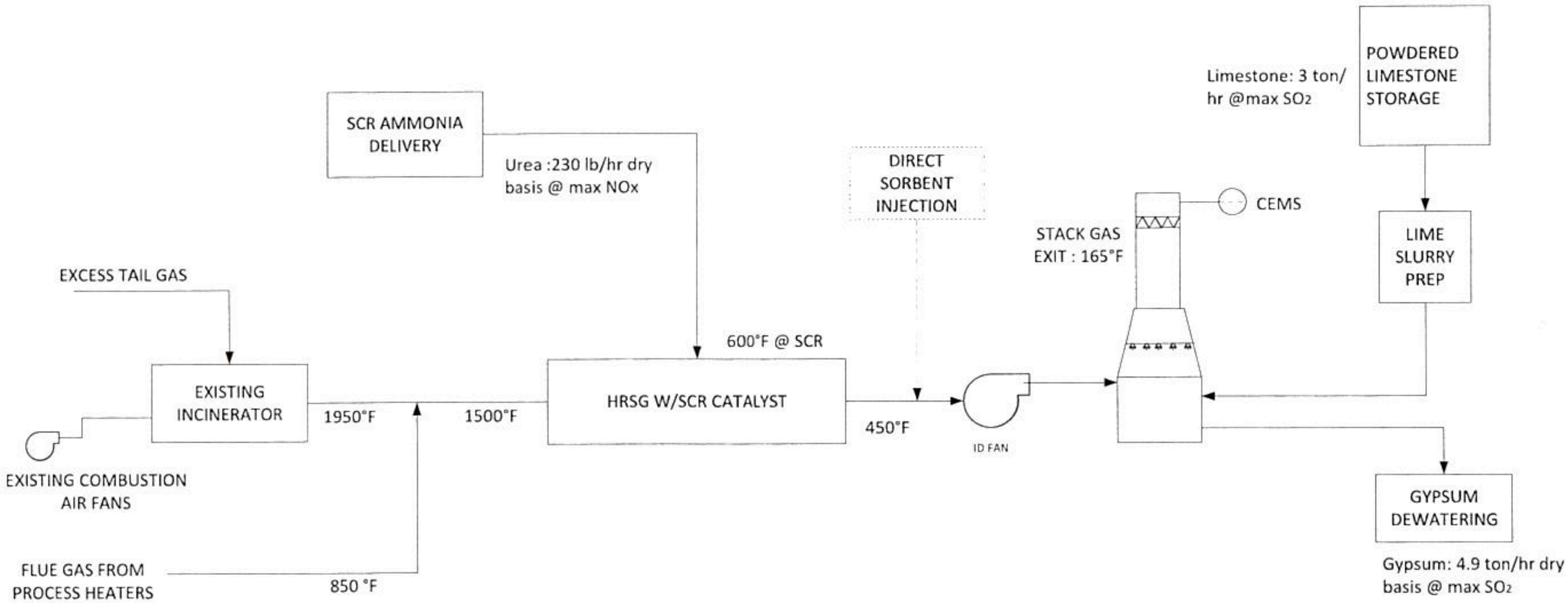
The final stage of dewatering will incorporate a vacuum belt filter which will dewater the gypsum to an approximate solids concentration of 85%. At the current maximum projected SO2 inlet concentration, gypsum production is expected to be approximately 4.9 ton/hr on a dry basis.

The exhaust gas emissions will be monitored by a continuous emissions monitoring system (CEMS) located at the exit of the absorber stack.

Cabot is also evaluating the potential to reduce SO_3 upstream of the WGS. If Cabot pursues this additional design element, Cabot may install a system to inject hydrated lime into the duct upstream of the induced draft (ID) fan.

A block flow diagram depicting the key components of the combined emissions control systems design for the Canal Facility (including the possible addition of the upstream SO2 reduction component) is presented in Figure 1.

FIGURE 1 – BLOCK FLOW DIAGRAM – CANAL SO_2 AND NO_x EMISSIONS CONTROL SYSTEMS



5.0 PROJECTED EMISSIONS PERFORMANCE

Table 2 summarizes the projected emissions from the controlled Process Systems at the Canal Facility based on the projected performance of the NOx and SO2 emissions control systems described in this Design Specification. As shown below, the expected performance of the systems will achieve the intended NO_x and SO_2 reduction goals identified in the Consent Decree.

TABLE 2 EXPECTED EMISSIONS PERFORMANCE

	7 day average	365 day average
SO_2 (ppmvd, 0% O_2)	120-157	80-115
NO_x (ppmvd, 0% O_2)	61	39

WGS systems are not a primary particulate removal device but have some PM removal capability. Based on the full range of inlet particulate loading, particulate size distribution and projected control rates, the total outlet emission rate for filterable particulate matter are projected to range from 0.015 gr/dscf, which would correspond to a 78% reduction from the inlet concentration, to 0.039 gr/dscf, which would correspond to a 44% reduction from the inlet concentration.

6.0 CONCLUSION

The foregoing design specification for the intended emissions control systems at the Cabot Canal facility demonstrates that the implementation of the SCR and WGS systems will meet the intended SO_2 and NO_X emission control objectives identified in the Consent Decree. The information in this document is subject to change until the equipment design is finalized; however, the control objectives for SO_2 and NO_X emissions from the relevant Process Systems at the Canal Plant identified in this design specification will be maintained through any refinements to the final design details.